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Ambient Noise Measurements in the Mississippi Sound

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14. ABSTRACT
During the spring, summer, and fall of 2004, underwater ambient noise measurements were conducted in the Mississippi Sound. The Naval Research Laboratory, Stennis Space Center (NRL – Stennis) and the Institute for Marine Mammal Studies (IMMS) collaborated in acquiring acoustic ambient noise data at eight (8) sites in the Mississippi Sound. The sites were chosen to represent sites of expected high anthropomorphic noise sources and a control site with few or no expected anthropomorphic noise sources. (Research supported by IMMS.)

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I. INTRODUCTION

The impact of anthropogenic acoustic noise on the behavior of bottlenose dolphin (*Tursiops truncatus*) in the Mississippi Sound is not well known. Anecdotal evidence suggests that such noise has a very detrimental effect on dolphin behavior. Contradictory anecdotal evidence also suggests that there is little or no detrimental effect. In some cases it can be inferred that dolphin enjoy certain activities in noisy environments (e.g., "bow riding"). An actual determination of the effects of anthropogenic noise on dolphin behavior requires more detailed knowledge of issues such as noise mechanisms and source distribution, dolphin population distributions, migratory habits and mechanisms, and vocalization characteristics. This project addresses the noise source aspect of these issues.

The Naval Research Laboratory Stennis Space Center (NRL - Stennis) and the Institute for Marine Mammal Studies (IMMS) performed an underwater ambient noise survey of the Mississippi Sound during the spring, summer, and fall of 2004. This study focused on assessing the ambient acoustic environment within the Mississippi Sound. This effort was a part of other ongoing dolphin studies that were being performed in collaboration with the IMMS and does not attempt to assess the impact of ambient noise on the behavior of *Tursiops truncatus*.

Underwater ambient noise measurements were taken at eight separate sites using a hydrophone deployed from a small boat. The measurement sites were chosen based on existing abundance and distribution studies [Lohoefener, 1990 and Mullin, 1988 and 1990; Scott, 1989; Solangi, 1983; and Thompson, 1982]. The sites included heavily trafficked

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and relatively quiet sites. The measurements were taken during selected times in the spring, summer, and fall. The data presented are for short time frames during the four seasons and are representative of the conditions that generally exist during these seasons. Dominant noise sources were determined, and special attention was given to anthropomorphic noise. The spectral and temporal natures of these data were also determined.

II. SITE SELECTION

The eight measurements sites that were chosen in the Mississippi Sound are shown in Fig. 1. Each site was chosen either for its fairly high or low amounts of human activity so as to provide a good estimate of the conditions throughout the sound. The eight sites are

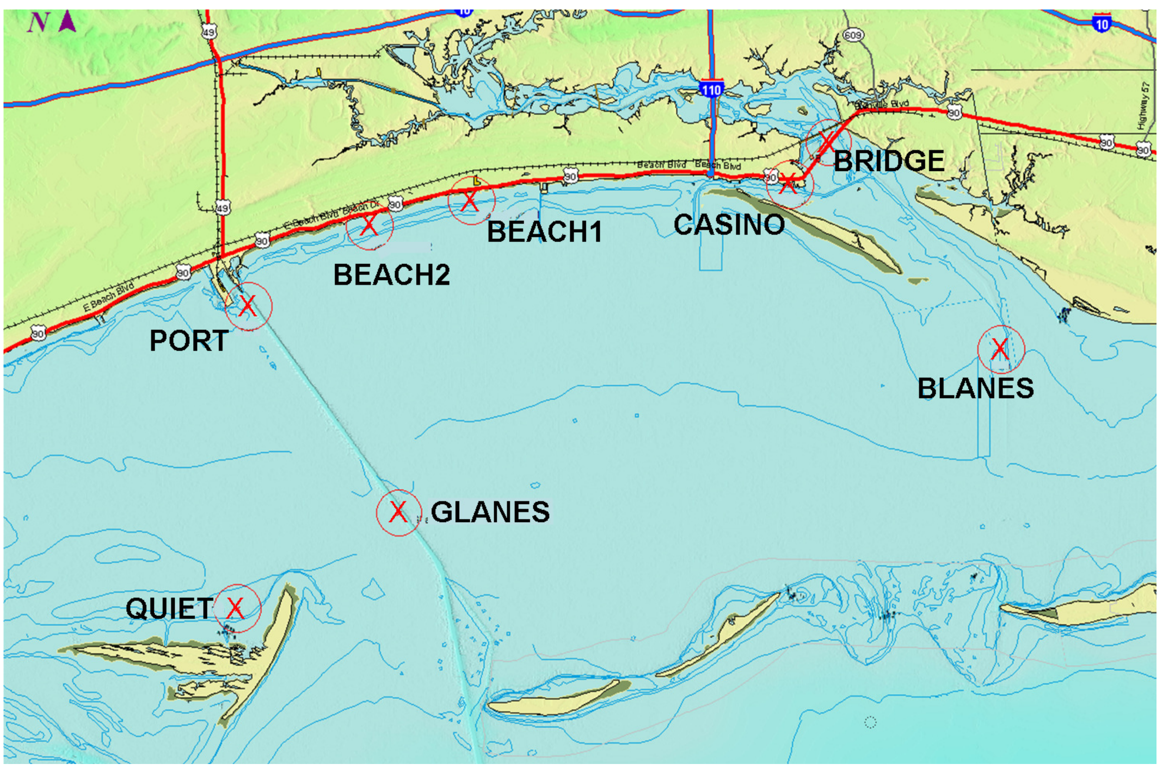

Figure 1. The eight measurement sites are displayed as PORT, QUIET, GLANES, BEACH1, BEACH2, BLANES, BRIDGE, and CASINO.

labeled as follows: PORT (near the port of Gulfport - commercial shipping activity), QUIET (near Cat Island), GLANES (the intersection of two of the Gulfport shipping lanes - commercial shipping), BEACH2 (a beach near Courthouse Road - recreational activity), BEACH1 (a beach near Edgewater Mall - recreational activity), BLANES (the intersection of three shipping lanes about six miles from Biloxi - fishing activity), CASINO (behind Magic Casino in Biloxi), and BRIDGE (the drawbridge site of the Biloxi Bay bridge – high automotive traffic).

PORT and GLANES were chosen because of the high incidence of commercial shipping. BEACH1 and BEACH2 were chosen because of the recreation water activity, although this activity is seasonal. BLANES was chosen because of the relatively high levels of fishing traffic. BRIDGE was chosen because of the potential for automotive-generated noise thought to be transmitted into the water via the bridge supports, especially during periods of high automotive traffic. Because of the barge-based casinos on the coast during this period, and the concern about the amount of noise they inject into the water, CASINO was chosen. QUIET is considered the control with few or no anthropomorphic noise sources expected. It should be noted that all sites had some level of recreation shipping activity, albeit sporadically.

Water depths at PORT, GLANES, and BLANES were approximately 10m. At QUIET the water depth was between 3-4m. At BEACH1, BEACH2, CASINO, and BRIDGE the water depth was less than 2m. The shallow depths for these latter sites required that the

measurements for BEACH1 and BEACH2 be made no closer than 75-100m from the shoreline.

Measurements were taken on three days in each season to facilitate averaging, potential equipment malfunctions, or drastically different environmental conditions. Measurements for spring 2004 were recorded on 15 April, 27 April, and 4 May, for summer 2004 on 8 July, 14 July, and 21 July, and for fall 2004 on 9 November, 12 November, and 16 November.

III. DATA ACQUISITION

Ambient noise was collected over a bandwidth that ranged from 1 - 70 kHz. Data were filtered using a Precision Instruments multi-pole bandpass anti-aliasing filter and digitized at 300 kHz using a National Instruments Inc. PC-based analog-to-digital converter (ADC) board. The data were stored directly to hard disk for later archiving to CD or DVD media. Operating parameters of the equipment were recorded for ultimate calibration of the acoustic measurement system. In addition, logs were kept on physical conditions and activities at the site, and any noise sources identified.

IV. PROCESSING AND ANALYSIS

Data from each hydrophone were spectrally processed and analyzed. The data were processed using a 4096 point FFT. One-minute spectrograms were obtained, and average spectra (about 60 sec) were obtained. A minimum of six minutes at each site was processed. Daily averages of the spectra for each site were obtained (not shown). These

were eventually averaged to obtain seasonal averages for each site. The average spectrum for the measurement period is shown by the red line in each of the spectral plots.

V. EXPERIMENTAL RESULTS

1. CAT ISLAND (QUIET) SITE

Figures 2, 3 and 4 show the ambient noise spectra for spring, summer, and fall at a site just north of Cat Island. This site was about 5 miles offshore. Initially, it was thought that this site was not subject to the environmental and shipping noise that was characteristic of the other sites. Figure 2 shows several noise spectra for the data taken in the spring of 2004. The three black curves are the average results over a 20 minute time interval. The red line

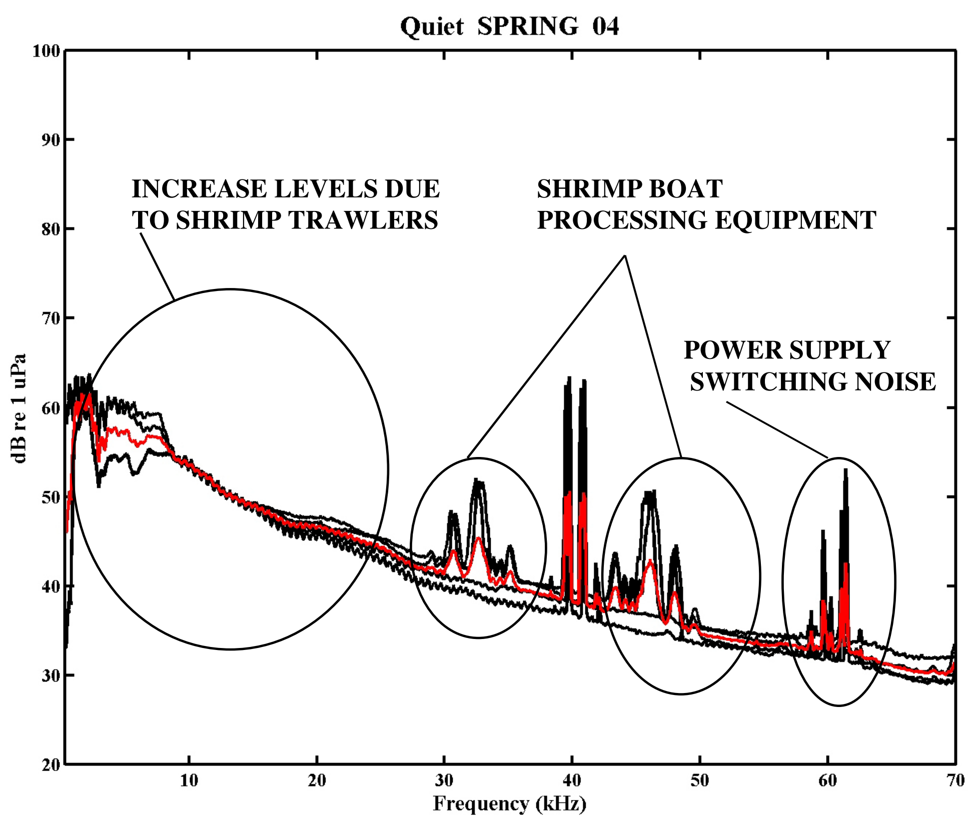

Figure 2. Ambient noise spectra during spring for the Cat Island site (QUIET).

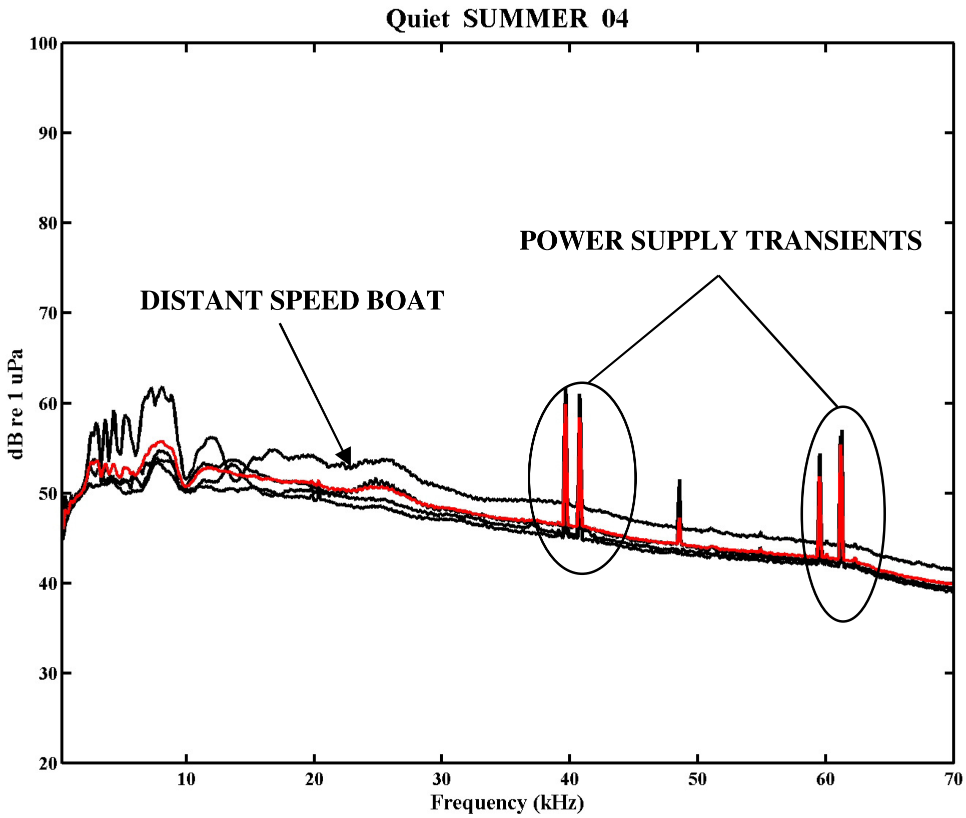

Figure 3. Ambient noise spectra during summer for the Cat Island site (QUIET).

is the average of the three curves. The results show elevated noise levels at frequencies less than 10 kHz that were generated by a shrimp trawler at the site. The levels due to the shrimp boat were found to be greater than 60 dB at the lowest frequencies. There were also additional higher frequency spikes at the 30 to 35 kHz and 40 to 50 kHz frequencies that are the result of processing equipment operating on board the trawler. Power supply switching transients are also shown.

Figure 3 shows three spectra for selected time frames during the summer season. During this measurement period, there were no shrimp trawlers at the site, but a distant high-speed

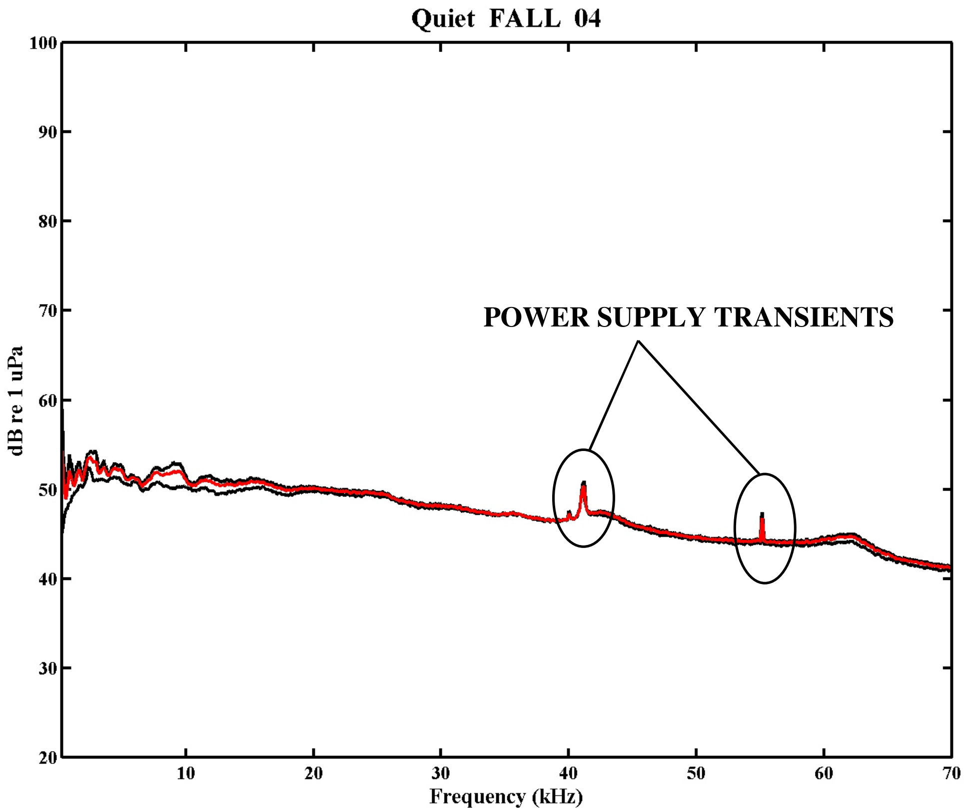

Figure 4. Ambient noise spectra during fall for the Cat Island site (QUIET).

pleasure craft was seen. That boat noise raised the levels by about 5 dB at the higher frequencies, and by at least 10 dB at the lower end of the spectrum.

Figure 4 is the spectra during the fall of 2004. As expected, the levels are low since there was little or no traffic at the site. The fluctuating levels at the lower frequencies were probably due to distant shipping or shore generated noise. The highest peaks were the result of the power supply switching transients.

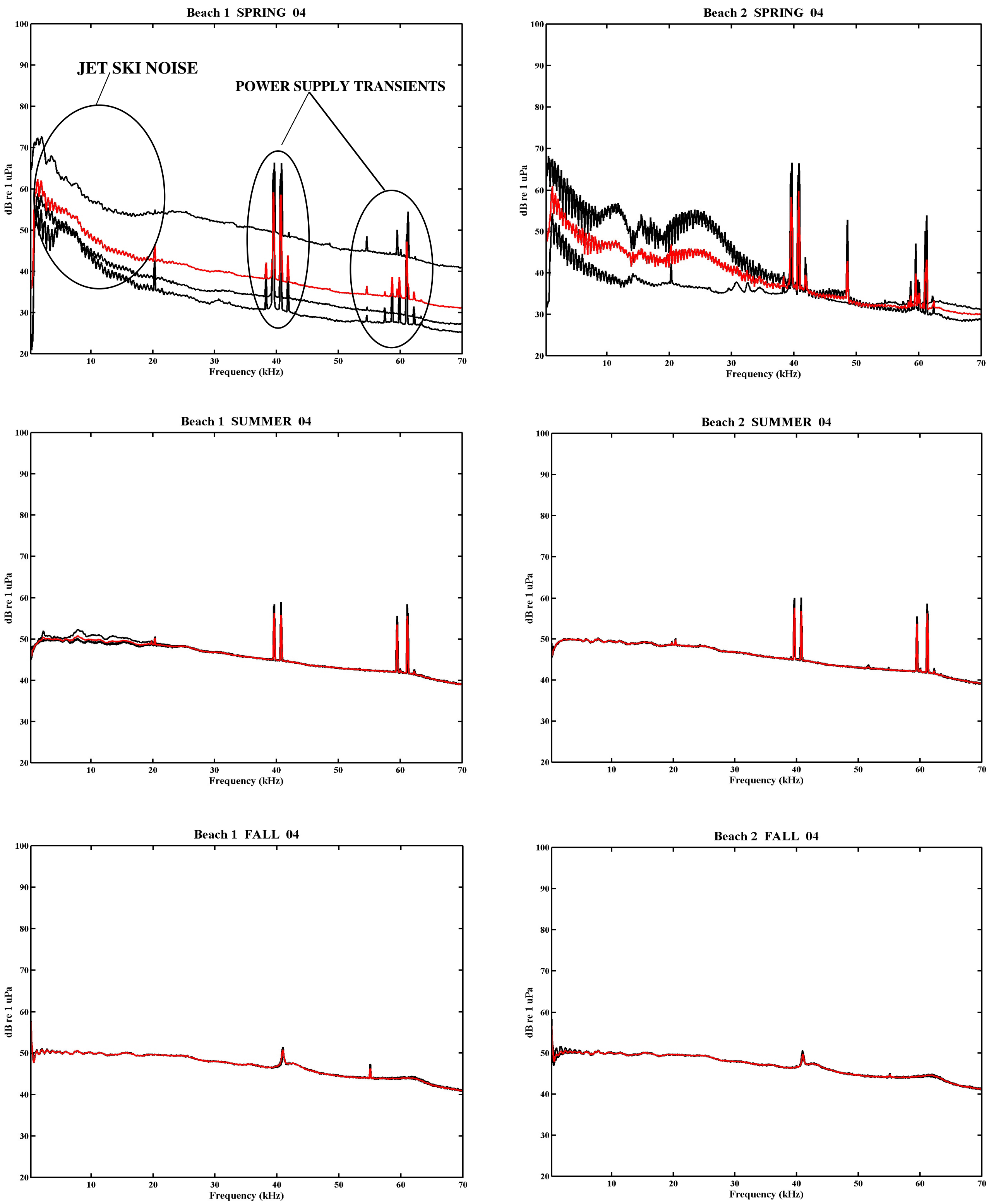

Figure 5. Ambient noise spectra during the spring, summer, and fall for the BEACH1 and BEACH2 sites.

2. BEACH SITES

Figure 5 shows the spectra for the two beach sites, BEACH1 and BEACH2, which were separated by about 2 km. The spring measurements were taken during a time when there was a lot of jet-ski activity. This is evident by the elevated levels below 20 kHz. The measurements taken during the summer and fall were taken when there was little water activity. The ambient noise spectra during both of these times ranged from 50 dB at the low-frequency end to about 40 dB at 70 kHz. During all these measurements the power supply switching transients are also present.

3. CASINO SITE.

The presence of barge-based casinos along the coast has raised concern as to the amount of

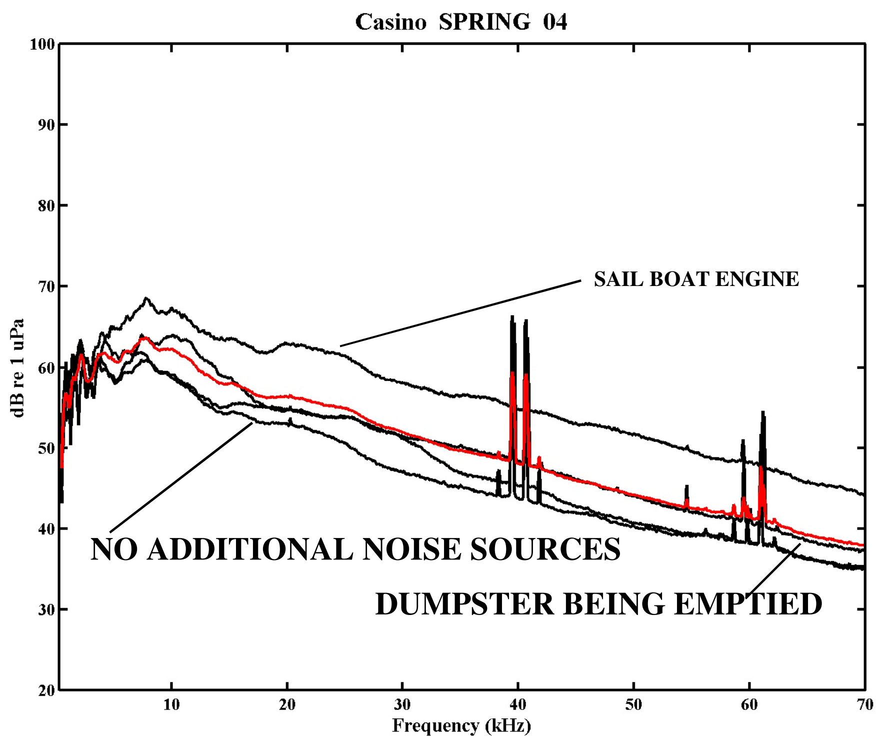

Figure 6. Ambient noise spectra during spring adjacent to the Magic Casino.

noise they might be injecting into the surrounding the waters. Figure 6 presents the results of a series of ambient noise measurements taken during the spring of 2004 at a site just south of the Magic Casino and a water depth of less that 10 m. At this site, the overall ambient noise levels are 10 to 15 dB higher than the levels at the beach sites. During this measurement period, a sailboat exited the marina running on its auxiliary engine, and a dumpster was emptied. The overall higher ambient noise levels can be attributed to both the noise being generated by the Casino's mechanical systems and the presence of biologics.

Figure 7 presents the results of ambient noise data taken during the summer and fall 2004. During these measurement periods the spectrum levels were comparable to the springtime levels when no noise sources were present. These low-frequency levels are about 10 dB higher that at the beach sites. The power supply transients are also present.

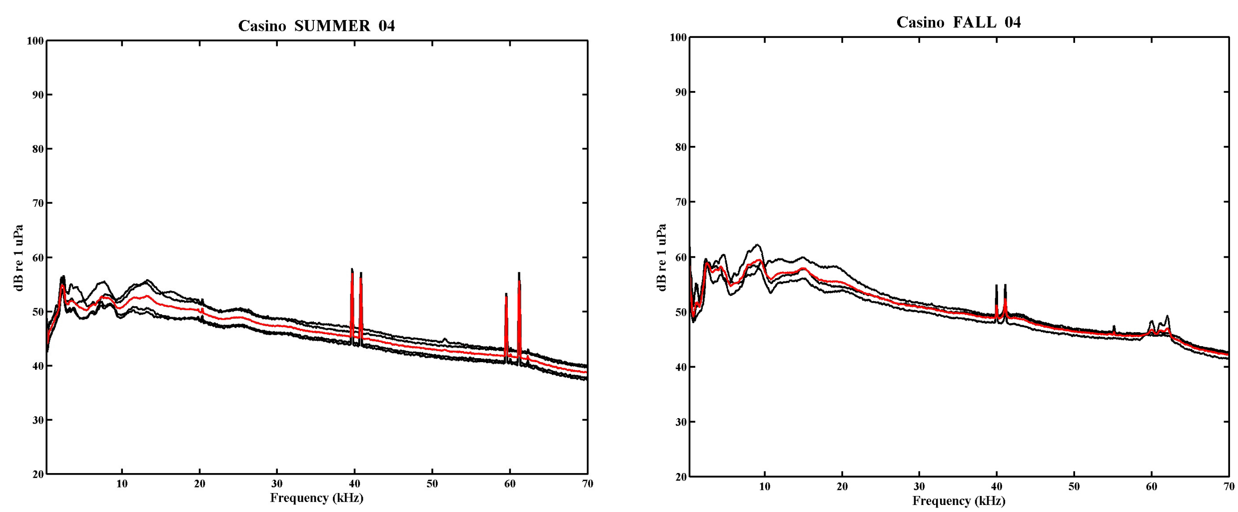

Figure 7. Ambient noise spectra measured during the summer and fall adjacent to the Magic Casino

4. BRIDGE SITE

The next series of measurements were taken in the spring and at a site very close to the Biloxi Bay Bridge (Fig. 8). During the measurement period, there was an increased amount of water and bridge traffic. During one measurement sequence, a large barge passed, and its signature raised the ambient levels across the entire frequency spectrum. Shrimp boats and heavy bridge traffic also raised the background levels. Additionally, there was a large ship and a few small pleasure craft present. In general, during this spring period, the ambient noise levels were higher across the entire spectrum.

Ambient noise measurements were also taken during the summer (Fig. 9) and fall

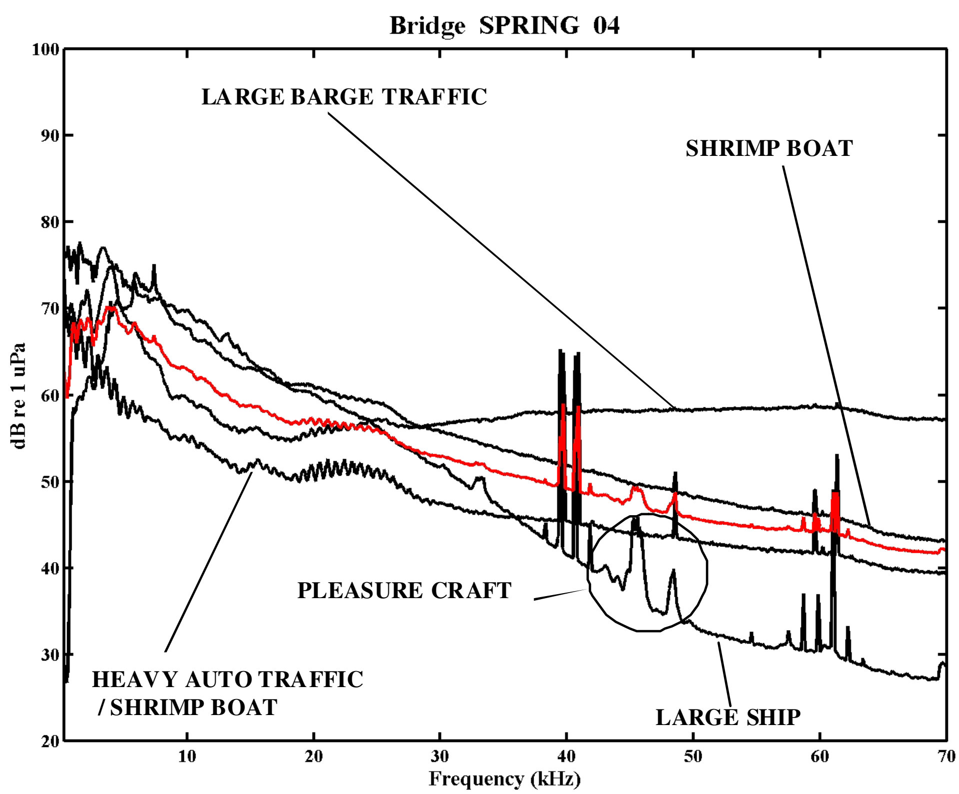

Figure 8. Ambient noise spectra during spring adjacent to the Biloxi Bay Bridge.

(Fig. 10). During the summer measurements period, the data were taken at a time when the bridge was closed to automotive traffic, and the traffic was waiting for the bridge to reopen (i.e., the drawbridge was up). The highest ambient noise levels at frequencies less that 10 kHz were close to 60 dB. There was also an increase in the noise levels as the drawbridge was closing. In the absence of a lot of watercraft and automotive traffic, the ambient levels approached those measured at the quiet beach sites.

The measurements taken in the fall were again characterized by several shrimp boats at the site. In all cases the switching power supply signatures were seen.

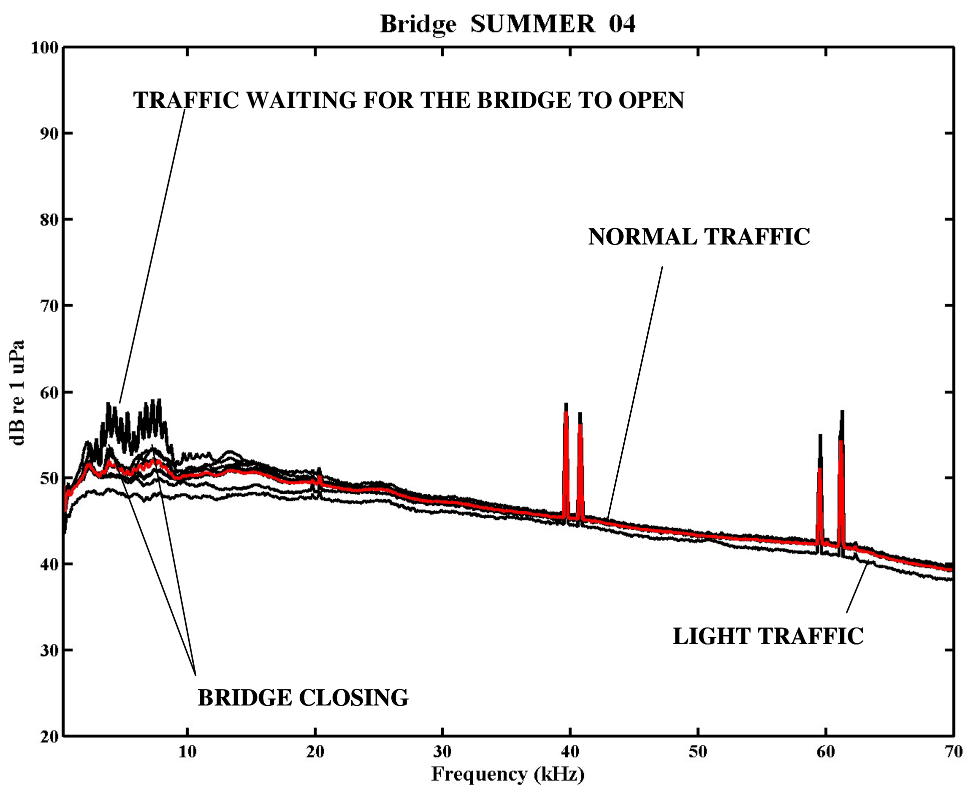

Figure 9. Ambient noise spectra measured during summer adjacent to the Biloxi Bay Bridge.

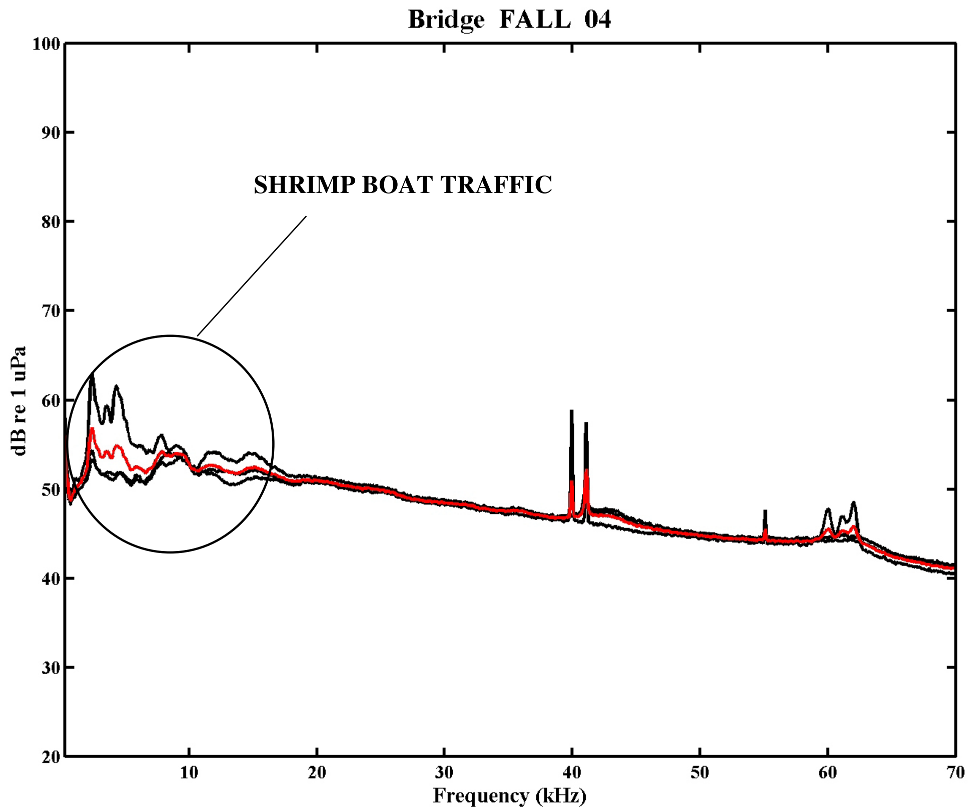

Figure 10. Ambient noise spectra measured during fall adjacent to the Biloxi Bay Bridge.

5. GLANES

Ambient noise measurements were taken at the intersection of two of Gulfport's commercial shipping lanes (Fig. 11). During the spring series of measurements, a large commercial freighter escorted by its pilot ship left the Gulfport Harbor. As expected, these two ships produced higher low-frequency ambient nose levels that approached 75 dB. Even when the ships were not at the immediate site, the noise levels were high. This was caused by several other ships that were moored at the harbor piers.

Additional measurements were taken in the summer (Fig. 12) and fall (Fig. 13) of 2004. In both these cases, the frequency spectrum was dominated by low-frequency shipping noise.

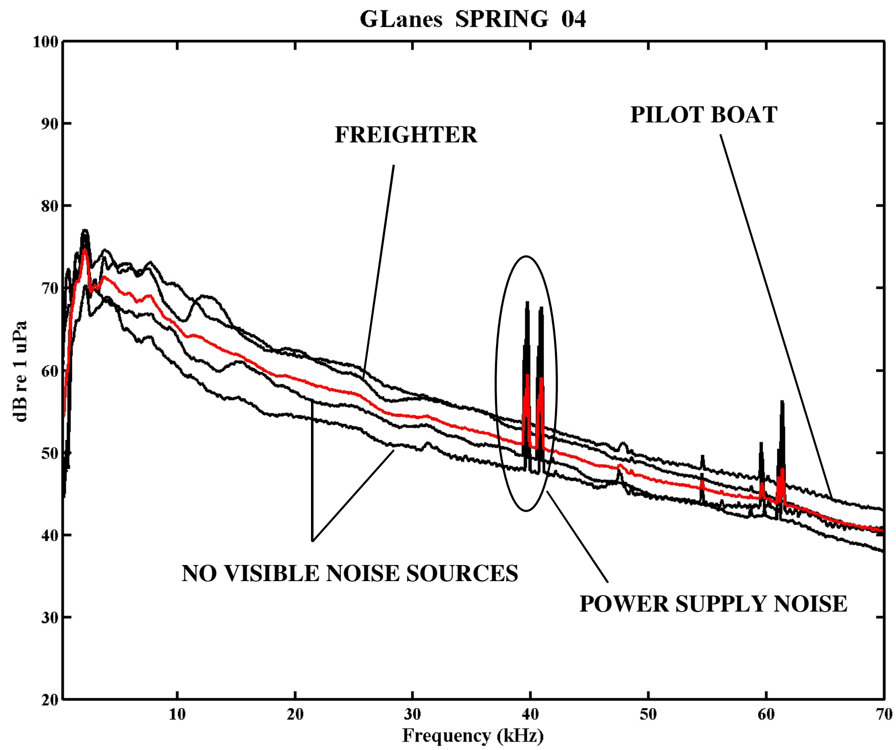

Figure 11. Ambient noise spectra taken during spring in the Gulfport shipping lanes.

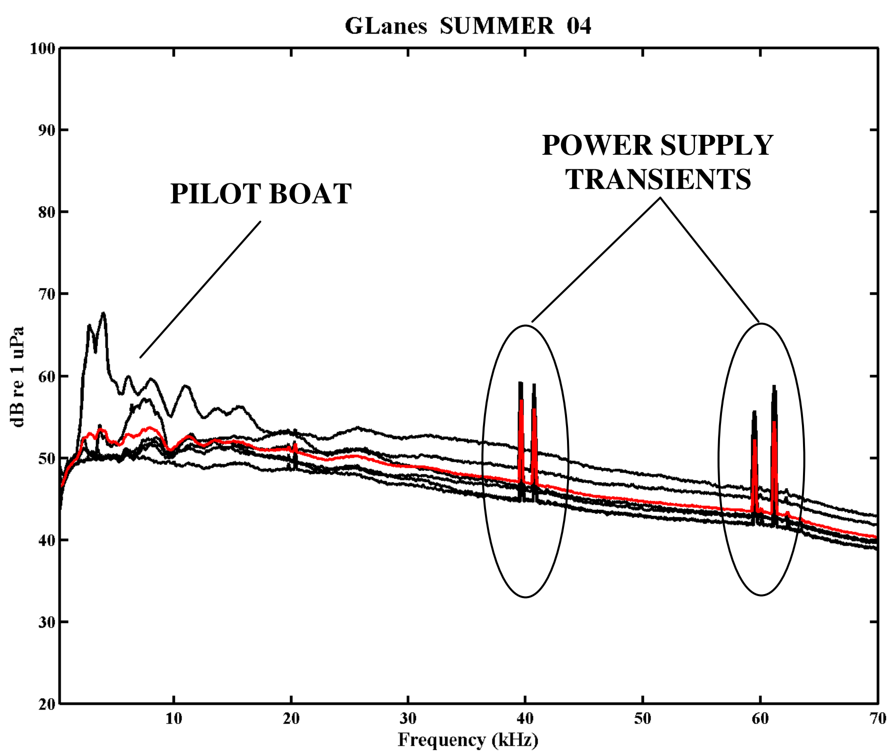

Figure 12. Ambient noise spectra taken during summer in the Gulfport shipping lanes.

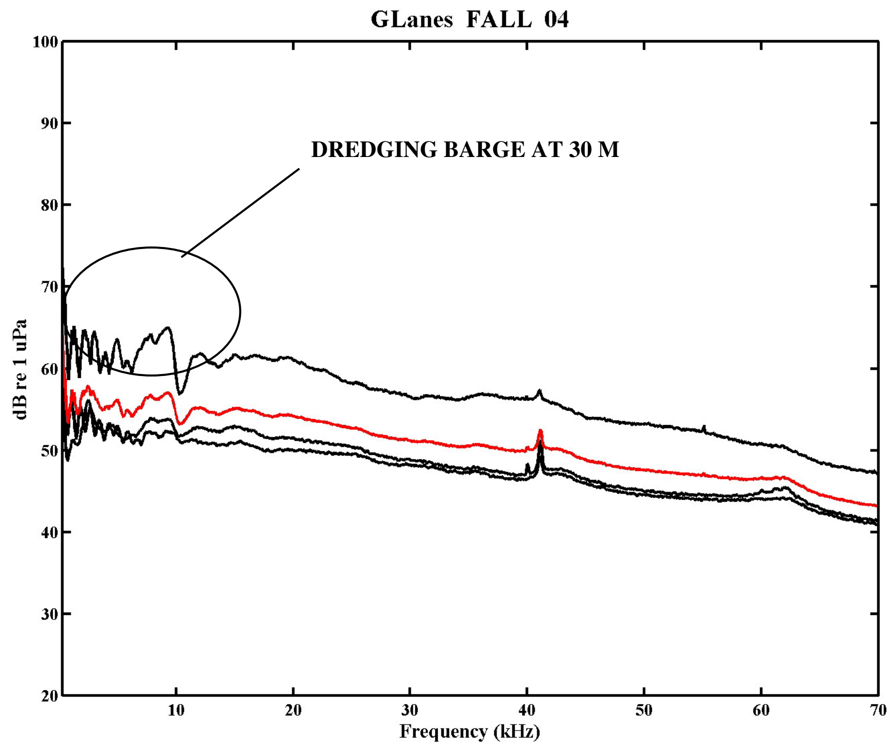

Figure 13. Ambient noise spectra taken during fall in the Gulfport shipping lanes.

When no noise sources were present, the ambient levels approached those of the quiet beach sites.

6. BLANES

This site is at the intersection of three shipping lanes, six miles south of Biloxi. Figure 14 shows the ambient noise levels measured during the spring at this site. The highest levels were measured when a barge was passing close to the measurement system. Ambient noise levels also increased when a port pilot ship passed. When there was no surface activity, the levels were low except at the extreme lower end of the spectrum (<2 kHz).

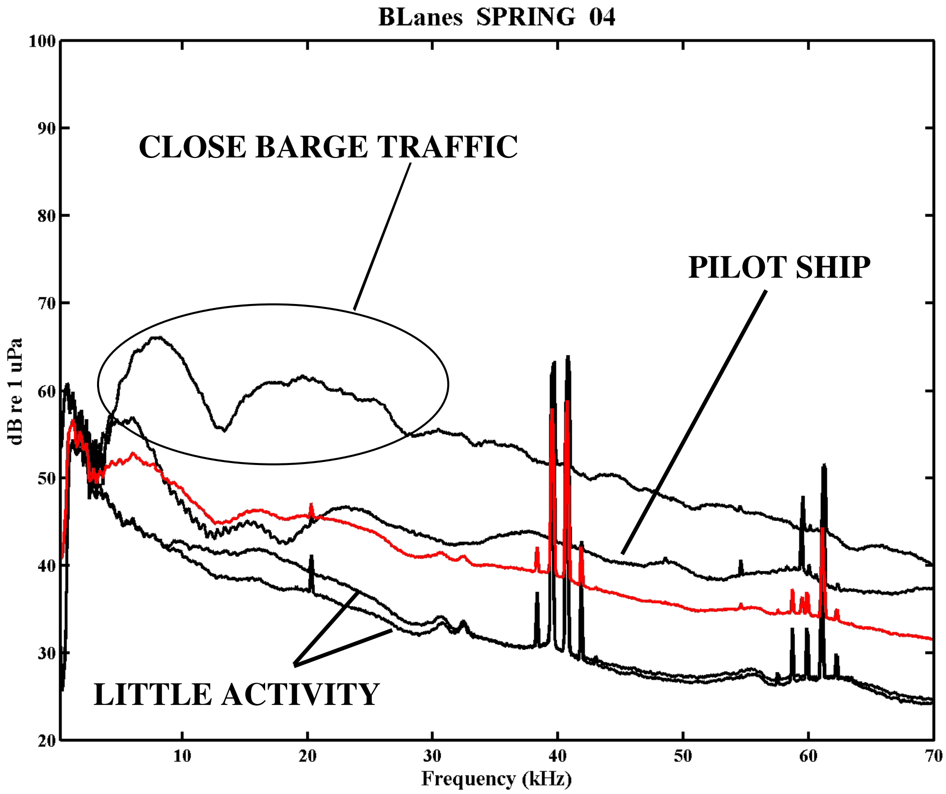

Figure 14. Ambient noise spectra taken during spring near the Biloxi shipping lanes.

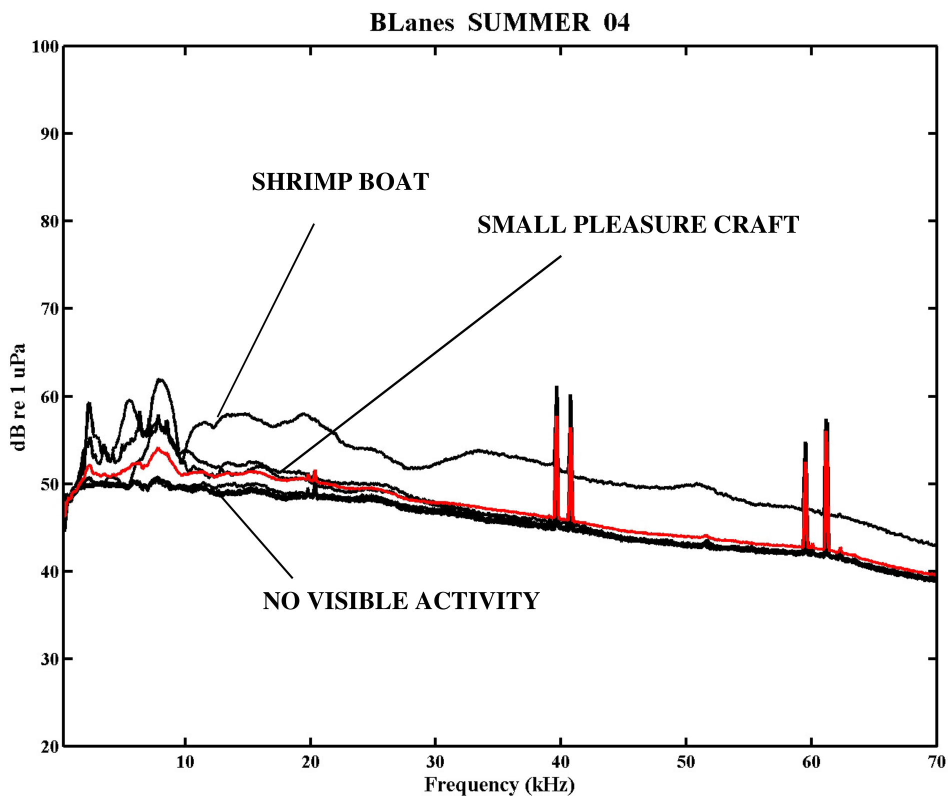

Figure 15. Ambient noise spectra taken during summer near the Biloxi shipping lanes.

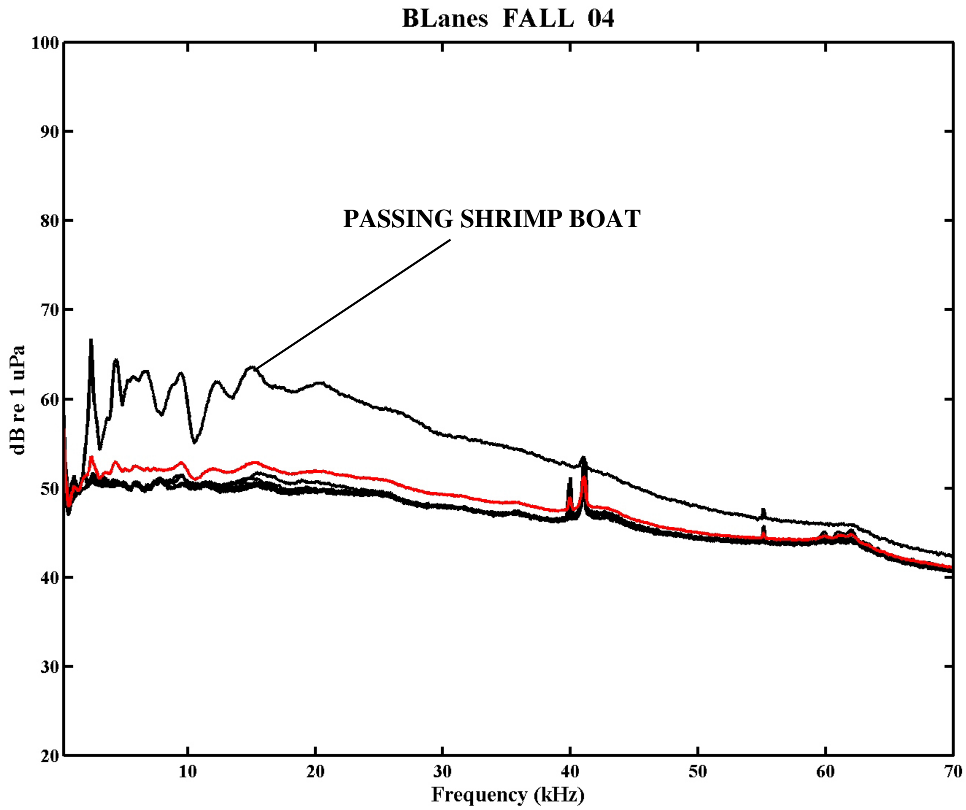

Figure 16. Ambient noise spectra taken during fall near the Biloxi shipping lanes.

Additional measurements were taken during the summer (Fig. 15). Ambient noise levels increased due to the passing of a small shrimp boat and several small distant pleasure craft. At the times when there was no visible activity, the background noise levels approached those levels that were measured at the beach sites.

Measurements taken during the fall (Fig. 16) again showed shrimp boat activity and some distant unidentified activity. However, in the fall, the water activity decreased with few pleasure craft at the site. During these times the ambient levels were close to the levels measured at the beach sites.

7. PORT

Figures 17, 18, and 19 show the results of ambient noise measurements taken in and around the port of Gulfport. During the spring, the highest levels were observed when a pier-side freighter was present (Fig. 17). These levels were greater that 70 dB at the low-frequency end of the spectrum. Even when there were no ships moving, the levels remained high throughout the harbor site.

Figure 18 shows the ambient noise levels taken during the summer. Again, the highest levels were measured when a shrimp boat was passing by the entrance to the harbor. The ambient levels were also high when the Ship Island ferry was outbound from the port. At

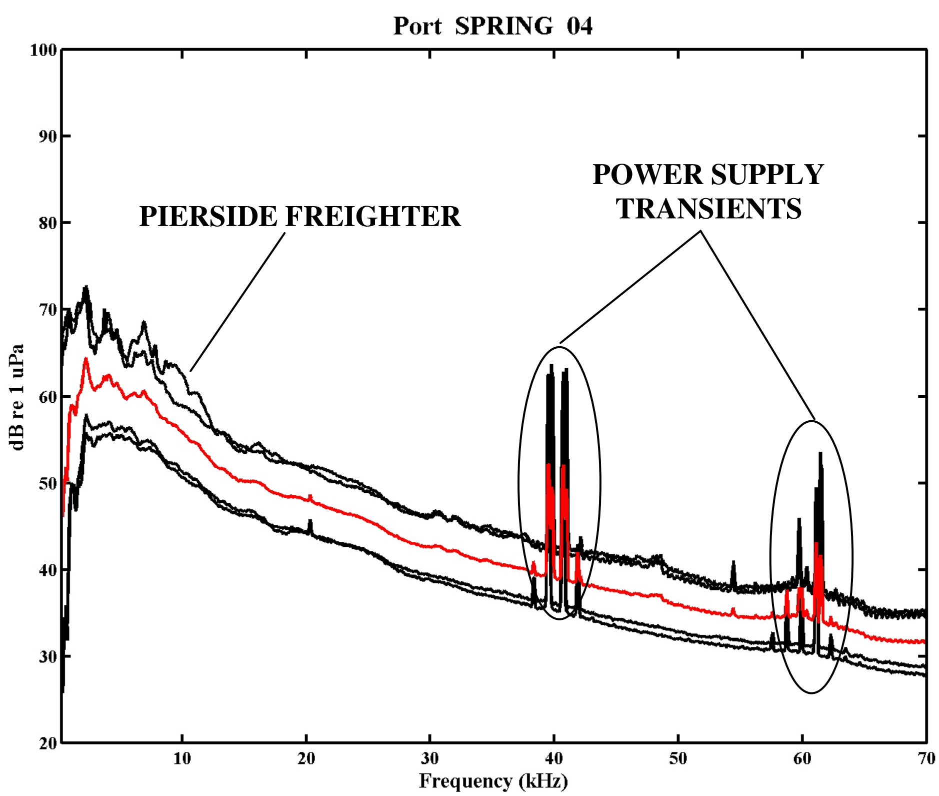

Figure 17. Ambient noise spectra taken during spring near the Gulfport harbor.

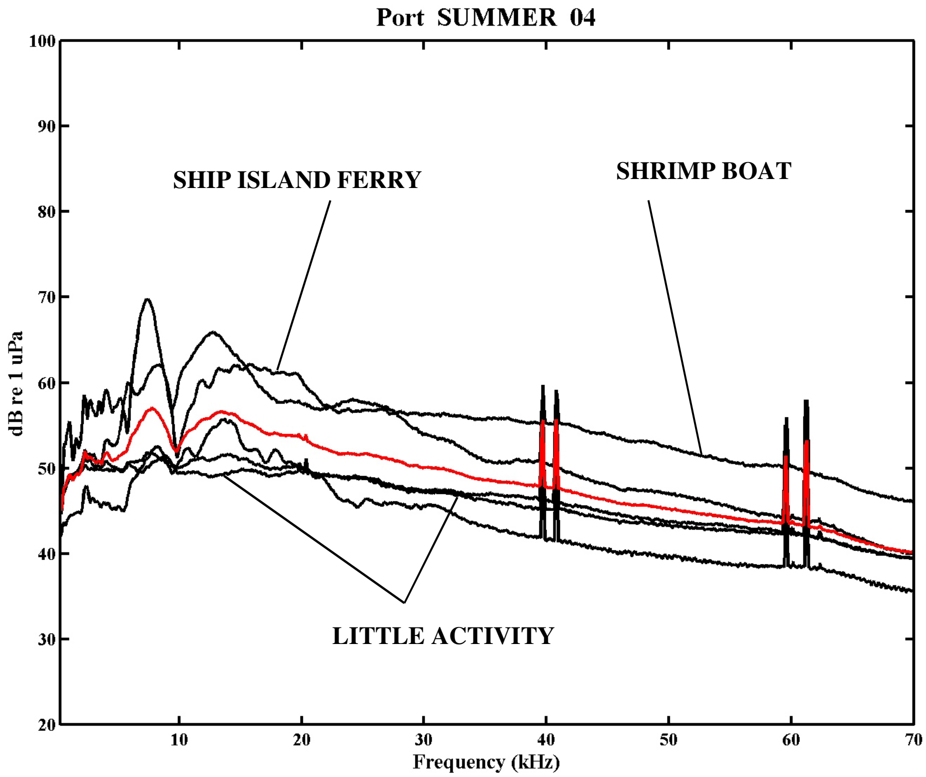

Figure 18. Ambient noise spectra taken during summer near the Gulfport harbor.

this time there were no ships in the harbor, and after the ferry passed, the levels were consistent with those at the beach sites. However, at the lowest frequencies (< 10 kHz), the levels were about 5 dB lower that the beach site levels.

Figure 19 shows the spectral noise due to a shrimp boat passing within 100 m with its processing equipment operating (38 kHz). After the passage of the shrimp boat, the levels approach those measured at the beach sites.

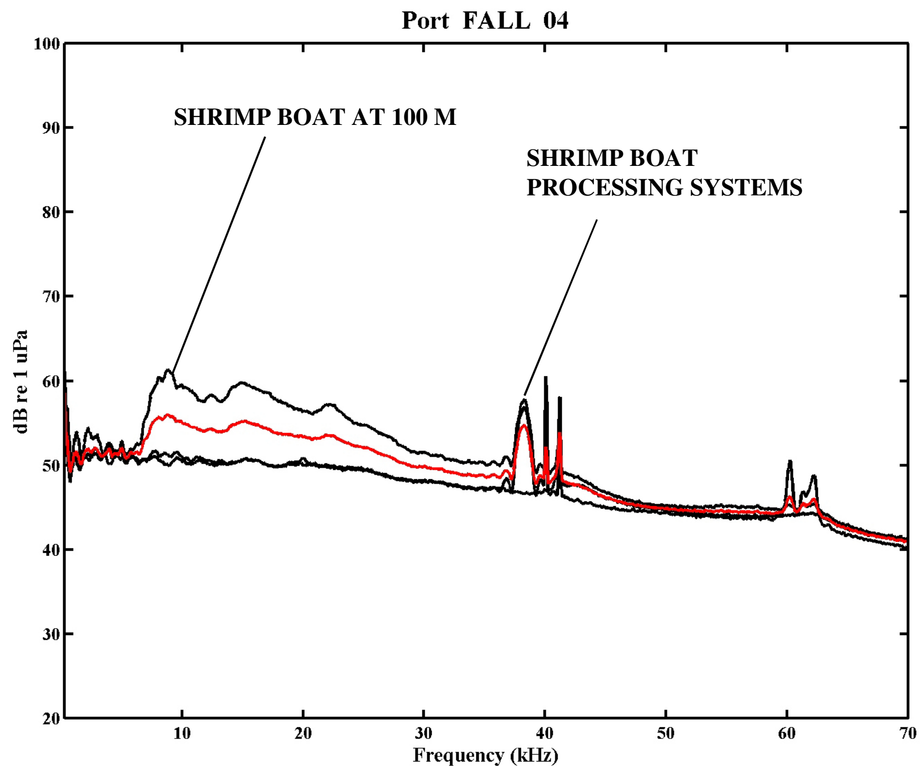

Figure 19. Ambient noise spectra taken in the fall in the Gulfport harbor.

VI. Summary and Conclusion

In the spring, summer, and fall of 2004 a series of underwater ambient noise measurements were taken at eight sites in the Mississippi Sound. The measurement sites ranged from very quiet beach sites to a site near the Gulfport harbor where noise levels were high. The sites with the lowest noise levels were the two beach sites. At all the measurement sites, the ambient noise levels were elevated by the presence of shrimp boats, freighters, barge traffic. At the bridge site, there was a measureable amount of energy transmitted from automobile traffic on the Biloxi Bay Bridge into the water. The presence of small boats and high-speed pleasure craft also contributed to an increase in the ambient levels. In the absence of these noise sources, the ambient levels in most of the sites approached those

measured at both of the beach sites. There was no correlation of noise levels with the season. In all sites, the levels were dominated mainly by various types of ship traffic.

VII. Acknowledgements

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